

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 753 796 A1

(12)

## EUROPEAN PATENT APPLICATION

(43) Date of publication:  
15.01.1997 Bulletin 1997/03

(51) Int Cl.<sup>6</sup>: G03F 7/20

(21) Application number: 96304965.5

(22) Date of filing: 05.07.1996

(84) Designated Contracting States:  
DE GB NL

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(30) Priority: 07.07.1995 JP 172067/95

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(54) Scanning exposure apparatus and device for manufacturing method using the same

(57) A scanning exposure apparatus wherein a mask stage (3) and a substrate stage (5) are moved in a timed relation and at a predetermined speed ratio whereby a projected image of a mask pattern is scanningly transferred onto a photosensitive substrate,

wherein, for higher throughput and higher efficiency pattern transfer, the scanning exposure is performed in accordance with a shot layout of the photosensitive substrate as determined per chip on the basis of information such as a chip structure or a chip size of the pattern.

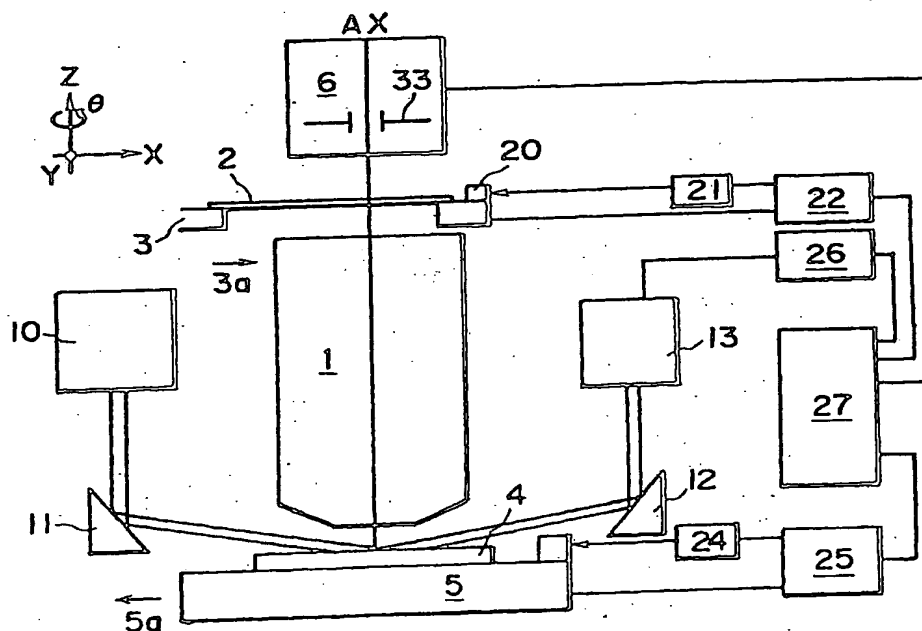


FIG. 1

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## Description

This invention relates to a scanning exposure apparatus and a device manufacturing method using the same. More particularly, the invention is concerned with a scanning exposure apparatus for use in manufacture of devices such as semiconductor devices or liquid crystal panels, for example, for scanningly projecting a pattern of a mask onto a photosensitive substrate by exposure and, in another aspect, it is concerned with a device manufacturing method using such exposure apparatus.

Photolithographic processes for manufacture of devices such as semiconductor devices (chips) or liquid crystal panels, for example, using a fine pattern, is performed generally by using a sequential motion type exposure apparatus (called a "stepper") for transferring, by exposure, a pattern of a mask (called a "reticle") onto a photosensitive layer (e.g., photoresist) applied to a semiconductor substrate (e.g., wafer) or a glass substrate.

In order to meet recent needs of increased density of device such as a DRAM, for example, or higher yield of devices, being required by semiconductor device manufacturers, stepper manufacturers have made efforts to develop projection optical systems enabling further miniaturization of printed pattern and further enlargement of picture field size. However, miniaturization of printed pattern and enlargement of picture field size involve increased difficulties of design or production of projection optical systems.

One solution for pattern miniaturization may be shortening the wavelength of exposure light source. In place of the bright line of i-line (wavelength  $\lambda = 365$  nm) of ultra-high pressure Hg lamps having been used prevalently, excimer lasers (wavelength  $\lambda = 248$  nm) will be used for 256M DRAM chips.

Another solution for the above-described problem may be a scanning exposure apparatus wherein a mask and a wafer are scanned and exposed while they are scanningly moved in opposite directions at a speed ratio corresponding to the magnification of a projection optical system.

As compared with an exposure region of a size 22x22 (mm) defined by a stepper, for example, a scanning exposure apparatus may define an exposure region of a size 26x33 (mm). For earlier 256M DRAM chips of a size 14x25 (mm), one chip can be produced by one shot. For shrink version 256M DRAM chips of a size 11x20 (mm), eight chips can be produced by one shot. Also, there is a multi-chip process wherein four 64M DRAM chips are coupled to provide a 256M DRAM chip. Such process of preparing plural chips in one shot will be used prevalently in manufacture of semiconductor devices.

For utilization of a wafer without loss, it is effective to perform pattern printing over the whole wafer surface. For shrink version 256M DRAM chips, for example, it results in an increase in production of a few chips, as

compared with a case where the whole surface is not exposed. If the pattern printing is to be performed to the whole surface of a wafer in the manner as shown in Figure 11, hatched portions S of a wafer 4 are overlaid on the edge of the wafer 4. Thus, the resultants provided by performing the pattern printing operation to such regions would not be used as devices.

Nevertheless, if the pattern printing is performed to the whole surface of a wafer by using a scanning exposure apparatus such as described above, the scanning time is wasted. This causes a decrease of throughput. There is an additional problem that additional exposure of such wafer region not contributable to semiconductor chip production will wastefully reduce the lifetime of a light source. Particularly when an expensive light source such as an excimer laser is used as an exposure light source, reduction of pulse lifetime is very undesirable.

Further, when the exposure process is to be performed per one shot, the focus measurement has to be done also per one shot. This makes the process complicated, in relation to the wafer peripheral portions.

It is accordingly an object of the present invention to provide a scanning exposure apparatus or a device manufacturing method by which patterns can be printed on a photosensitive substrate with higher throughput and without loss.

In accordance with an aspect of the present invention, there is provided an exposure apparatus, comprising: a mask stage for holding a mask having an original pattern and being reciprocally movable along a scan direction; a projection optical system for projecting at least a portion of the original pattern at a predetermined magnification; a substrate stage for holding a photosensitive substrate on an imaging plane of said projection optical system and being reciprocally movable along the scan direction; wherein said mask stage and said substrate stage are able to be moved simultaneously or in a timed relation and at a speed ratio corresponding to the magnification of said projection optical system by which a projected image of the original pattern is scanningly printed on shots of the photosensitive substrate; and control means for controlling the scanning exposure on the basis of a shot layout of the photosensitive substrate which is determined per chip from information related to a chip structure and a chip size of the original pattern.

The shot layout may be recorded prior to the scanning exposure and wherein said control means controls the scanning exposure in accordance with the record. Said apparatus may further comprise a light blocking plate disposed at one of a position adjacent to the mask and a position optically conjugate with the mask and being reciprocally movable along the scan direction, wherein, when the original pattern is scanningly printed on the photosensitive substrate, said light blocking plate may be moved in a timed relation with a boundary of an exposure region of the mask and at a speed ratio to the mask corresponding to the magnification.

In accordance with another aspect of the present

invention, there is provided a scanning exposure method usable with a mask stage for holding a mask having an original pattern and being reciprocally movable along a scan direction, a projection optical system for projecting at least a portion of the original pattern at a predetermined magnification, and a substrate stage for holding a photosensitive substrate on an imaging plane of the projection optical system and being reciprocally movable along the scan direction, said method comprising the steps of: moving the mask stage and the substrate stage in a timed relation and at a speed ratio corresponding to the magnification of the projection optical system by which a projected image of the original pattern can be scanningly printed on shots of the photosensitive substrate; determining a shot layout of the photosensitive substrate per chip from information related to a chip structure and a chip size of the original pattern; and controlling the scanning exposure in accordance with the shot layout.

The shot layout may be recorded prior to the scanning exposure and wherein the scanning exposure is controlled in accordance with the record.

In accordance with a further aspect of the present invention, there is provided a device manufacturing method usable with a mask stage for holding a mask having an original pattern and being reciprocally movable along a scan direction, a projection optical system for projecting at least a portion of the original pattern at a predetermined magnification, and a substrate stage for holding a photosensitive substrate on an imaging plane of the projection optical system and being reciprocally movable along the scan direction, said method comprising the steps of: moving the mask stage and the substrate stage in a timed relation and at a speed ratio corresponding to the magnification of the projection optical system by which a projected image of the original pattern can be scanningly printed on shots of the photosensitive substrate, for manufacture of devices; determining a shot layout of the photosensitive substrate per chip from information related to a chip structure and a chip size of the original pattern; and controlling the scanning exposure in accordance with the shot layout.

The shot layout may be recorded prior to the scanning exposure and wherein the scanning exposure is controlled in accordance with the record.

Briefly, in accordance with one aspect of the present invention, in the scanning exposure process for wafer peripheral portions, the exposure process is not performed per one single shot but it is performed per a chip or chips which are effective. In the multi-chip procedure described hereinbefore, for a 256M DRAM for example, those for a 64M DRAM may be considered as one chip and the exposure process may be performed to them.

To this end, the layout may be designed so as to get a largest number of chips, while taking into account the chip structure or chip size. During the scanning exposure, for a case where only one chip of three chips of one shot is to be exposed, for example, the scan for ex-

posure may be performed for the one chip and the scan for the others may not be performed any more. This enables elimination of scan of unnecessary regions, and it enables enhancement of throughput. Also, it avoids unnecessary exposure and enables enhancement of lifetime of the light source.

As regards the focus measurement to wafer peripheral portions, since there is no exposure region lying outside the wafer surface, it is assured that the measurement is surely performed upon the wafer surface. There is no necessity of a peculiar procedure to wafer peripheral portions, and this reduces the possibility of measurement error.

Embodiments of the present invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic and diagrammatic view of a scanning exposure apparatus according to an embodiment of the present invention.

Figure 2 is a schematic view for explaining an exposure region of a wafer and focus measurement points.

Figure 3 is a schematic view for explaining a shot layout on the surface of a wafer.

Figure 4 is a schematic and diagrammatic view of a scanning exposure apparatus according to another embodiment of the present invention.

Figure 5 is a flow chart for explaining the exposure operation in the first embodiment of Figure 1.

Figure 6 is a schematic view for explaining the exposure operation in the first embodiment of Figure 1.

Figure 7 is a flow chart for explaining the exposure operation in another embodiment of the present invention.

Figure 8 is a schematic view for explaining the exposure operation in the embodiment of Figure 7.

Figure 9 is a schematic view for explaining an example of shot layout to be processed in a stepper.

Figure 10 is a schematic view for explaining a shot layout corresponding to that of Figure 9 but to be processed in accordance with an embodiment of the present invention.

Figure 11 is a schematic view for explaining a shot layout on a wafer, including those portions from which no chip could be produced.

Figure 1 shows a projection exposure apparatus according to an embodiment of the present invention. In this embodiment, the invention is applied to a projection exposure apparatus of what can be called "step-and-scan type", wherein wafer movement and wafer exposure are repeated in a step-and-repeat process while, on the other hand, the exposure of every shot of the wafer is performed by scanning exposure.

Denoted in Figure 1 at 1 is a reduction projection lens (projection optical system) having an optical axis AX extending in parallel to a Z axis of an X-Y-Z coordinate system as illustrated. The projection lens 1 has an image plane which is perpendicular to the Z-axis direction. Reticle (mask) 2 is held on a reticle stage 3. Pattern

of the reticle 3 is projected in a reduced scale of 1:4 to 1:2 corresponding to the magnification of the projection lens 1, the projected image being formed upon the image plane of the reduction projection lens 1.

Denoted at 4 is a semiconductor wafer having a photoresist applied to its surface, to provide a photosensitive substrate. There are a number of exposed regions (shot regions) disposed in array, having been defined through a preceding exposure process or processes. Denoted at 5 is a stage on which the wafer 4 is placed. It comprises a chuck for attracting and fixing the wafer 4 to the wafer stage 5, an X-Y stage movable horizontally in X and Y directions, respectively, a leveling stage movable in the Z-axis direction corresponding to the optical axis direction of the projection lens 1 and being rotationally movable about the X and Y axes, and a rotatable stage being rotationally movable about the Z axis. Thus, it provides a six-axis correction system adapted to register shot regions of the wafer 4 with a projected image of the reticle 2 pattern formed by the projection lens 1.

Denoted in Figure 1 at 10, 11, 12 and 13 are components of a focus and tilt detection optical system which serves to detect the position of the surface of the wafer 4 with respect to the optical axis AX and any tilt of that surface with respect to the X-Y plane. Denoted specifically at 10 is a light projecting system by which a plurality of (six, for example) parallel light beams are produced. These light beams are directed by way of a mirror 11 to six measurement points upon the wafer 4 surface. While only two light beams are illustrated in Figure 1, each beam represents three light beams located in the direction of depth (perpendicular direction) of the sheet of the drawing.

Upon the wafer 4 surface, as shown in Figure 3, there are plural shot regions (regions onto which the pattern of the reticle 2 is to be transferred) disposed in array. The six light beams projected by the light projecting system 10 are incident, as best seen in Figure 2, on six separate measurement points CL1, CL2, CL3, CR1, CR2 and CR3 of a shot region.

Reflected light beams from the wafer 4 are received by a light receiving system 13, by way of a mirror 12. The light receiving system 13 is arranged to perform tilt correction so that the measurement points CL1 - CL3 and CR1 - CR3 on the wafer 4 surface are placed in an optically conjugate relation with the detection surface of the light receiving system 13. Thus, the position of a pinhole image upon the detection surface of the light receiving system 13 does not change with any local inclination of the measurement points CL1 - CL3 and CR1 - CR3. Rather, in response to any change in level (height) of the measurement points with respect to the optical axis AX direction, the pinhole image displaces on the detection surface of the light receiving system 13.

Now, the scanning exposure operation in this embodiment will be explained. As shown in Figure 1, after the reticle 2 is attracted to and held fixed to the stage 3,

it is scanningly moved in the X-axis direction in Figure 1, along the X-Y plane perpendicular to the optical axis AX of the projection lens 1, at a constant speed. Simultaneously, as regards the Y-axis direction (perpendicular to the sheet of the drawing), it is correctively moved so as to constantly assure that a target coordinate position is scanned. Positional information related to the reticle stage 2 with respect to the X-axis and Y-axis directions, is measured continuously by means of a laser interferometer system 21 wherein plural laser beams are projected from reticle side laser interferometers 21 (for measurements in X and Y axes) to half mirrors 20 (for measurements in X and Y axes) which are fixedly mounted on the reticle stage 3.

Exposure illumination system 6 comprises a light source (not shown), such as an excimer laser, for example, adapted to produce light pulses, and it includes components such as a beam shaping optical system, an optical integrator, a collimator and a mirror, for example, all being unshown in the drawing. These components are made of a material or materials efficiently passing or reflecting the pulse light which is in the deep ultraviolet region. The beam shaping optical system serves to transform the sectional shape (including size) of a received light beam into a desired shape, and the optical integrator serves to uniform the distribution characteristic of light so that the reticle 2 is illuminated with uniform illuminance.

Exposure illumination optical system 6 further includes a masking blade 33 which is disposed at a position optically conjugate with the surface of the reticle 2. It serves to define an illumination region 34 of rectangular shape, corresponding to the chip size of the wafer 4. As shown in Figure 2, a portion of the pattern of the reticle 2 as partially illuminated with the illumination region 34, is projected by the projection lens 1 onto the wafer 4 surface which is coated with the resist.

Main control unit 27 shown in Figure 1 serves to control the whole system of the apparatus, so as to perform the scanning exposure while adjusting and placing a slit image of the reticle 2 within a particular region on the wafer 4, at a particular position on the X-Y plane (with respect to the positions in X-axis and Y-axis directions as well as the position with respect to the rotational direction about an axis parallel to the Z axis) and at a position in the Z-axis direction (with respect to the position in the rotational directions  $\alpha$  and  $\beta$  about axes parallel to the X and Y axes, respectively, as well as the position of level (height) along the Z-axis direction). More specifically, as regards the alignment of the reticle pattern along the X-Y plane, control data is calculated out of the position data from the reticle side laser interferometer system 21 and from a wafer stage side laser interferometer system 24, as well as out of the position data for the wafer 4 which is obtainable from an alignment microscope system (not shown). Based on the calculated control data, the reticle position control system and the wafer position control system 25 are controlled.

When the reticle stage 3 is scanned in the direction of an arrow 3a shown in Figure 1, the wafer stage 5 is scan-  
 ningly moved in the direction of an arrow 5a shown in Figure 1 at a speed corrected in accordance with the  
 reduction magnification of the projection lens 1. The  
 scanning speed of the reticle stage 3 is determined,  
 while taking into account the width, in the scan direction,  
 of the masking blade 33 within the exposure illumination  
 optical system 6 and the sensitivity of the resist applied  
 to the wafer 4 surface, so that higher throughput is as-  
 sured.

Alignment of the reticle pattern and the wafer 4 sur-  
 face with respect to the Z-axis direction, namely, align-  
 ment in reference to the image plane, is performed by  
 controlling the leveling stage of the wafer stage 5  
 through the wafer position controlling system 25, in ac-  
 cordance with the result of calculation by a surface po-  
 sition detecting system 26 which serves to detect the  
 level of the wafer 4 on the basis of the output of the light  
 receiving system 13. More specifically, from the level da-  
 ta of three wafer level measurement light spots which  
 are located in the vicinity of the exposure region 34 (see  
 Figure 2), with respect to the scan direction, any tilt in  
 the direction perpendicular to the scan direction as well  
 as the level in the optical axis AX direction are calculat-  
 ed. Then, the amount of correction for optimum image  
 plane position, at the exposure position, is detected, and  
 the correction is performed.

Next, the shot layout determination procedure will  
 be explained. The layout input is performed by using an  
 input terminal (not shown) connected to the main control  
 unit 27. From this input terminal, the shape or size of a  
 wafer 4, shot size, chip size, chip location within shot as  
 well as its coordinates, for example, are inputted at first,  
 and they are memorized into storing means, not shown.  
 After being inputted, the information is read out of the  
 storing means by a computer and, from that information,  
 the layout of a largest number of chips that can be pro-  
 vided by the wafer, to be used, is determined.

If one shot comprises plural chips, a shot layout that  
 assures a shortest exposure time for the wafer is deter-  
 mined on the basis of combinations of the determined  
 chip layout. After the layout determination, correspond-  
 ing layout information is transmitted to the main control  
 unit 27 through a communication line, so that the scan-  
 ning exposure is performed in the exposure process in  
 accordance with the determined layout.

The procedure of exposure operation will be ex-  
 plained below. First, description will be made on an ex-  
 ample where a blank shot 101 in Figure 3 is going to be  
 exposed. It is assumed that, in the case of the shot 101,  
 the exposure process is going to be performed in an or-  
 der from chip 101a to chip 101c.

The reticle stage 3 and the wafer stage 5 are moved  
 so as to place and set the reticle 2 and the wafer 4 at  
 the exposure start point. Until that moment, the shutter  
 for exposure light has not yet been opened. Then, the  
 exposure light shutter is opened, and the exposure proc-

ess starts. During the exposure process, the reticle 2  
 and the wafer 4 are scaningly moved while correcting  
 the focus of the wafer 4, tilt of the image plane and the  
 position of the reticle 2 and the wafer 4. After scan of  
 one shot is completed, the shutter is closed and the wa-  
 fer stage 5 is moved to the position for the subsequent  
 shot.

Subsequently, as depicted by hatching in Figure 3,  
 description will be made on the procedure of exposure  
 operation for a shot wherein only one chip (the size cor-  
 responding to the chip 101a in Figure 3) or two chips  
 (the size corresponding to the combined size of the  
 chips 101a and 101b) can be taken. Particularly, in this  
 example, the scan exposure is performed in a direction  
 from the central side of the wafer toward the outside  
 thereof. Also, in this example, the scan in the exposur-  
 process is performed only with respect to the chip or  
 chips to be exposed. Figure 5 illustrates the exposure  
 sequence in this example, and Figure 6 illustrates the  
 relationship between the reticle 2 and the opening 34 of  
 the masking blade 33. Since the wafer 4 is moved rela-  
 tively to the masking blade 33 in a similar manner as the  
 reticle 2, it is not shown in Figure 6.

The example of Figure 6 is a case wherein one shot  
 comprises three chips and, of these chips A, B and C,  
 description will be made on the exposure of the chip A  
 only.

First, as illustrated in Figure 6(A), the edge of the  
 exposure region 34 is placed upon the edge of the chip  
 A of the reticle 2 (step 51). Since in this case the scan  
 direction is from the central side of the wafer 4 toward  
 the outside thereof, the edge of the chip A is registered  
 with the edge of the pattern of the reticle 2. Also, it is  
 assumed that the required precision for setting the edg-  
 es of them can well be satisfied by the driving precision  
 of them. If sufficient setting precision is not attainable by  
 the mechanical precision because of the relation of ret-  
 icle pattern layout, for example, a separate mechanism  
 for aligning them may be provided.

After the edges are aligned with each other, the ex-  
 posure light shutter is opened, and the exposure proc-  
 ess starts (step 52). Simultaneously with the shutter  
 start, the scan of the reticle 2 starts. At that time, on the  
 wafer 4 side, the focus measurement is performed with  
 respect to the focus measurement points CR1, CR2 and  
 CR3 which are on the side of the exposure region 34  
 that is going to be exposed. Then, as the points on the  
 wafer 4, whose Z-axis positions have been measured  
 in relation to the measurement points CR1, CR2 and  
 CR3, enter the exposure region 34, correction is made  
 in accordance with the results of measurement, so as  
 to bring the wafer surface into coincidence with the best  
 focus plane of the projection lens 1.

Additionally, the scan operation is performed while  
 correcting tilt of the image plane or relative positional  
 deviation between the reticle and the wafer, for example,  
 through an alignment mechanism (not shown) (step 58).  
 Figure 6(B) illustrates the state during the scan opera-

tion. In this manner, the scan operation is continued at a constant speed until all the region of the chip A passes throughout the exposure region 34. As all region of the chip A passes the exposure region 34, as shown in Figure 6(C), the exposure light shutter is closed and the exposure process is discontinued (step 54). Then, the stage is moved to a position for start of exposure of the subsequent shot (step 55). In that occasion, a portion other than the layout is exposed. Since however such portion corresponds to the hatched region S in Figure 11 where it is inherently eclipsed by the edge of the wafer, there occurs no problem.

As described above, in peripheral shots, scanning exposure operation for unnecessary regions can be omitted. Thus, the throughput can be increased and the lifetime of the exposure light source can be prolonged.

A second embodiment of the present invention will be described. Also this embodiment has a feature in the point of exposure of wafer peripheral shots. In this embodiment, the scan direction for exposure of wafer peripheral portion is from the outside of a wafer toward the inside thereof. Also in the example to be described below, the scan for exposure is performed only with respect to the chip or chips to be exposed.

Figure 7 illustrates the exposure sequence, and Figure 8 illustrates the relationship between the reticle 2 and the opening 34 of the masking blade 33. Since the wafer moves relative to the masking blade in a similar manner as the reticle, it is not illustrated in Figure 8.

The example of Figure 8 is a case wherein one shot comprises three chips and, of these chips A, B and C, description will be made on the exposure of the chip A only.

First, as illustrated in Figure 8(A), the edge of the exposure region 34 is placed upon the edge of the chip A (step 71). Since in this case the scan direction is from the outside of the wafer toward the inside thereof, the edge of the chip A is the one which is at the boundary with the chip B. Also, it is assumed that the required precision for setting the edges of them can well be satisfied by the driving precision of them. If sufficient setting precision is not attainable by the mechanical precision because of the relation of reticle pattern layout, for example, a separate mechanism for aligning them may be provided.

After the edges are aligned with each other, the exposure light shutter is opened, and the exposure process starts (step 72). Simultaneously with the shutter start, the scan of the reticle 2 starts. At that time, on the wafer 4 side, the focus measurement is performed with respect to the focus measurement points CL1, CL2 and CL3 which are on the side of the exposure region 34 that is going to be exposed. Then, as the points on the wafer 4, whose Z-axis positions have been measured in relation to the measurement points CL1, CL2 and CL3, enter the exposure region 34, correction is made in accordance with the results of measurement, so as to bring the wafer surface into coincidence with the best focus

plane of the projection lens 1.

Additionally, the scan operation is performed while correcting tilt of the image plane or relative positional deviation between the reticle and the wafer, for example, through an alignment mechanism (not shown) (step 73). Figure 8(B) illustrates the state during the scan operation. In this manner, the scan operation is continued at a constant speed until all the region of the chip A passes throughout the exposure region 34. As all region of the chip A passes the exposure region 34, as shown in Figure 8(C), the exposure light shutter is closed and the exposure process is discontinued (step 74). Then, the stage is moved to a position for start of exposure of the subsequent shot (step 75).

As described above, in peripheral shots, scanning exposure operation for unnecessary regions can be omitted. Thus, the throughput can be increased and the lifetime of the exposure light source can be prolonged.

A third embodiment of the present invention will be described. This embodiment corresponds to an example wherein, for exposure of wafer peripheral shots, the first and second embodiments described hereinbefore are used in combination. This enables efficient scanning exposure with enhanced throughput even for the wafer peripheral shots, in accordance with the scan direction for exposure of an adjacent shot thereto.

A fourth embodiment of the present invention will be described with reference to Figure 4. In this embodiment, a light blocking plate 31 which is reciprocally movable in the same direction as the scan direction of the reticle 2, is provided within the exposure illumination system 6, at a position adjacent to the masking blade or a position which is optically conjugate with the masking blade. For exposure of only a portion of one shot, it is moved, under the control of the control device 32, with the exposure region boundary at a scan seed that reflects the magnification in relation with the reticle 2. This is effective to remove the limitation to the exposure scan direction, for wafer peripheral shots. Except for the procedure of exposure of wafer peripheral shots, the operation is essentially the same as that of the first embodiment.

The procedure of exposure operation to wafer peripheral portion in accordance with this embodiment, will be explained. The scan of exposure may be performed only to the chip or chips to be exposed. In this case, however, it is necessary to scaningly move the light blocking plate 31 of the exposure illumination optical system 6 in the direction of an arrow 31a in Figure 4 (under assumption that the reticle 2 and the masking blade 33 are inverted by a single imaging action), with the exposure region boundary and at a speed corrected in accordance with the magnification of an imaging lens (not shown) provided between the reticle 2 and the light blocking plate 31. This is because, if the above is not taken, an unnecessary portion is exposed due to the opening of the masking blade 31. Thus, for a shot which is not going to be exposed totally, the light blocking plate

31 is moved together with the reticle 2 and the wafer 4 to perform the scanning exposure.

The provision of such movable light blocking plate such as at 31 removes the limitation to the exposure scan direction in relation to wafer peripheral shots. Thus, it enables selection of operation with lesser loss, and it assures enhancement of throughput.

A fifth embodiment of the present invention will be described. This embodiment is adapted for what can be called a "mix-and-match" procedure wherein a wafer having been exposed by a stepper is going to be processed by a scanning exposure apparatus. Also in this embodiment, an example wherein one shot comprises three chips will be explained.

Figure 9 illustrates a shot layout of seventy-two (72) chips having been printed by means of a stepper. Hatched regions T depict those regions in which a chip or chips partially overlie on the edge of the wafer 4 so that no semiconductor product is obtainable therefrom. If the layout is remade per chip, for exposure of the wafer 4 by a scanning exposure apparatus, a layout such as shown in Figure 10 enables a smallest number of shots (sixty-eight shots). If the exposure process is performed in accordance with the layout the same as that of the stepper such as shown in Figure 9, the scanning exposure has to be done to seventy-two shots. As compared therewith, the shot layout modified as shown in Figure 10 enables sixty-eight shots, and it removes the necessity of scan exposure for four shots. Thus, the throughput increases accordingly.

In accordance with one aspect of the present invention as has been described hereinbefore, in the layout preparation, the layout is determined per chip. This enables omitting scanning exposure for unnecessary regions, and it assures enhanced throughput. Also, it makes it possible to prolong the lifetime of the exposure light source.

The exposed substrate with the chip patterns on can then be processed in the conventional manner as is well known in the art e.g. etching of the photosensitive material, and deposition of further layers to fabricate a device or devices such as semiconductor devices (chips) or liquid crystal panels.

While the invention has been described with reference to the structures disclosed herein, it is not confined to the details set forth and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

#### Claims

1. An exposure apparatus, comprising:

a mask stage for holding a mask having an original pattern and being reciprocally movable along a scan direction;

a projection optical system for projecting at least a portion of the original pattern at a predetermined magnification;

a substrate stage for holding a photosensitive substrate on an imaging plane of said projection optical system and being reciprocally movable along the scan direction;

wherein said mask stage and said substrate stage are able to be moved in a timed relation and at a speed ratio corresponding to the magnification of said projection optical system by which a projected image of the original pattern is scaningly printed on shots of the photosensitive substrate; and

control means for controlling the scanning exposure on the basis of a shot layout of the photosensitive substrate which is determined per chip from information related to a chip structure and a chip size of the original pattern.

2. An apparatus according to Claim 1, wherein the shot layout is recorded prior to the scanning exposure and wherein said control means controls the scanning exposure in accordance with the record.
3. An apparatus according to Claim 1, further comprising a light blocking plate disposed at one of a position adjacent to the mask and a position optically conjugate with the mask and being reciprocally movable along the scan direction, wherein, when the original pattern is scaningly printed on the photosensitive substrate, said light blocking plate is moved in a timed relation with a boundary of an exposure region of the mask and at a speed ratio to the mask corresponding to the magnification.
4. A scanning exposure method usable with a mask stage for holding a mask having an original pattern and being reciprocally movable along a scan direction, a projection optical system for projecting at least a portion of the original pattern at a predetermined magnification, and a substrate stage for holding a photosensitive substrate on an imaging plane of the projection optical system and being reciprocally movable along the scan direction, said method comprising the steps of:

moving the mask stage and the substrate stage in a timed relation and at a speed ratio corresponding to the magnification of the projection optical system by which a projected image of the original pattern can be scaningly printed on shots of the photosensitive substrate; determining a shot layout of the photosensitive substrate per chip from information related to a chip structure and a chip size of the original pattern; and controlling the scanning exposure in accord-

ance with the shot layout.

5. A method according to Claim 4, wherein the shot layout is recorded prior to the scanning exposure and wherein the scanning exposure is controlled in accordance with the record. 5

6. A device manufacturing method usable with a mask stage for holding a mask having an original pattern and being reciprocally movable along a scan direction, a projection optical system for projecting at least a portion of the original pattern at a predetermined magnification, and a substrate stage for holding a photosensitive substrate on an imaging plane of the projection optical system and being reciprocally movable along the scan direction, said method comprising the steps of: 10 15

moving the mask stage and the substrate stage in a timed relation and at a speed ratio corresponding to the magnification of the projection optical system by which a projected image of the original pattern can be scaningly printed on shots of the photosensitive substrate, for manufacture of devices; 20 25

determining a shot layout of the photosensitive substrate per chip from information related to a chip structure and a chip size of the original pattern; and

controlling the scanning exposure in accordance with the shot layout. 30

7. A method according to Claim 6, wherein the shot layout is recorded prior to the scanning exposure and wherein the scanning exposure is controlled in accordance with the record. 35

8. A device manufacturing method comprising the scanning exposure method of claim 4 or claim 5 including the step of fabricating a device from the exposed photosensitive substrate. 40

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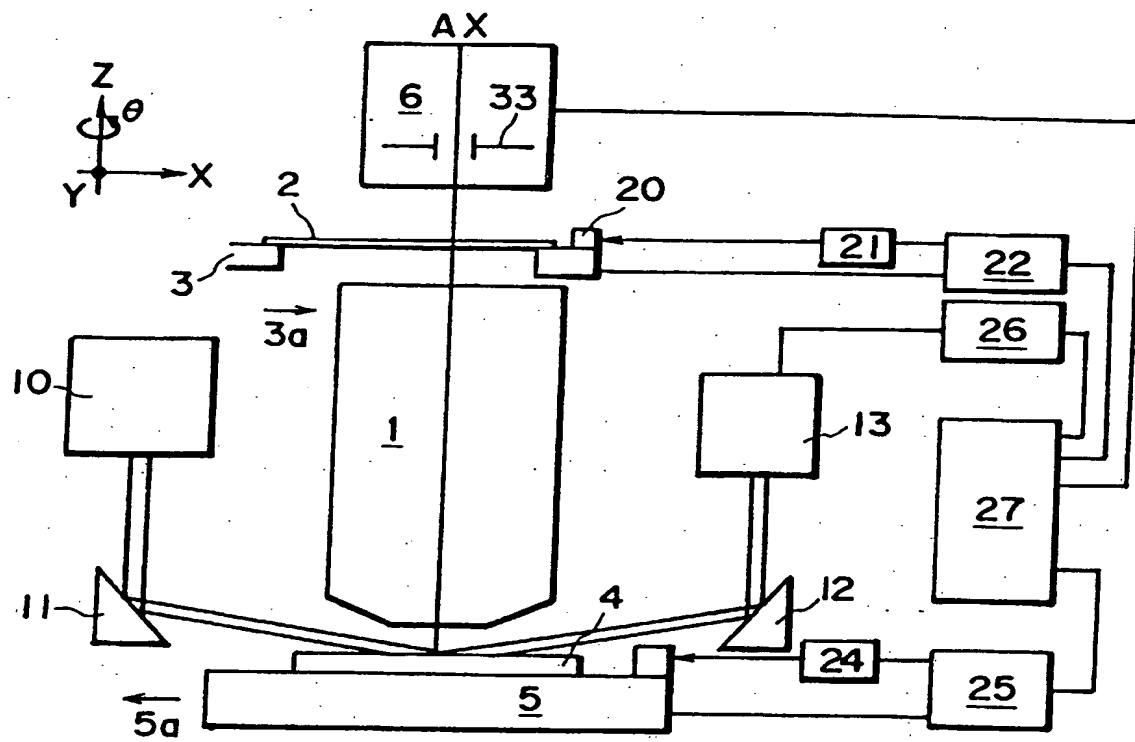


FIG. 1

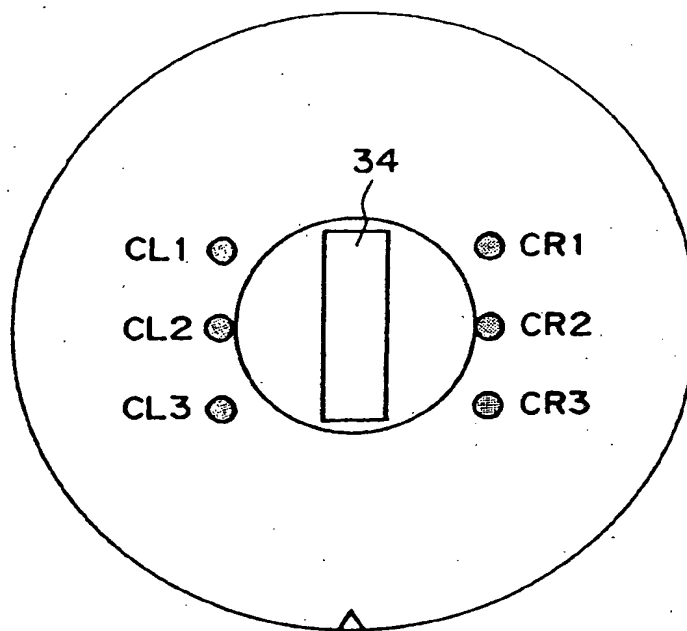


FIG. 2

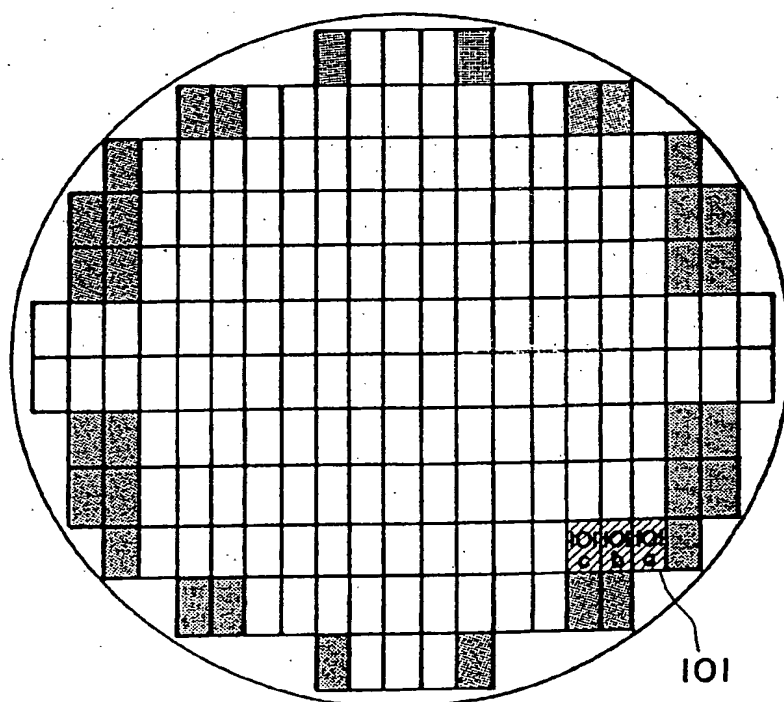


FIG. 3

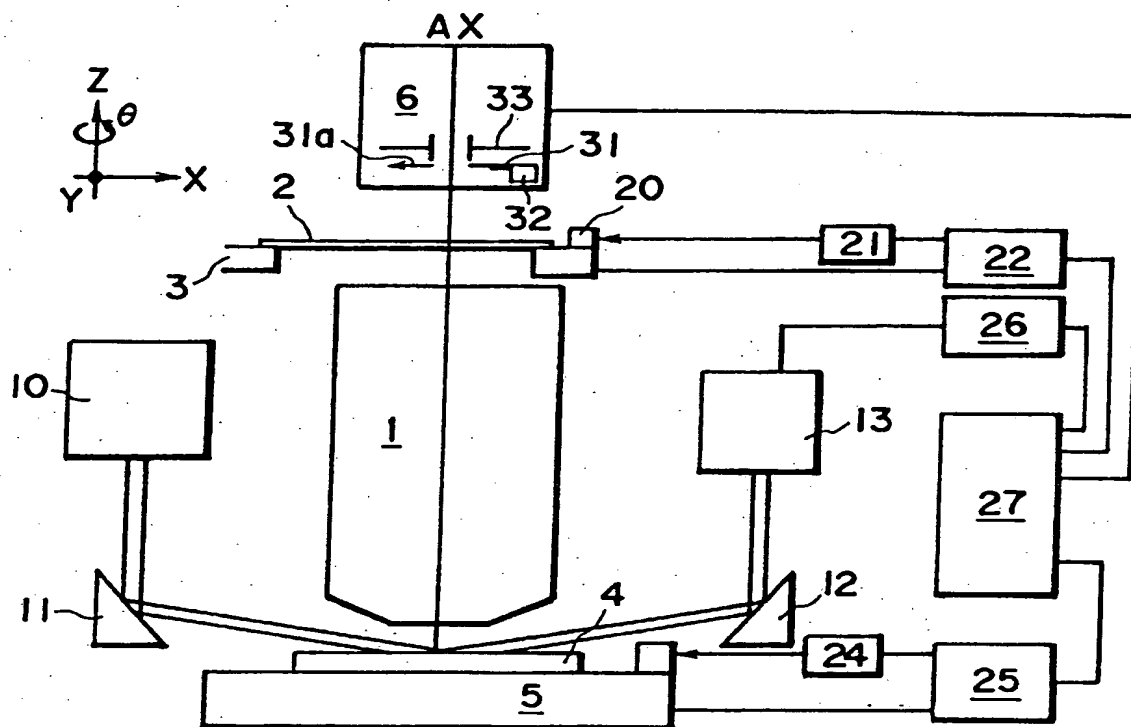


FIG. 4

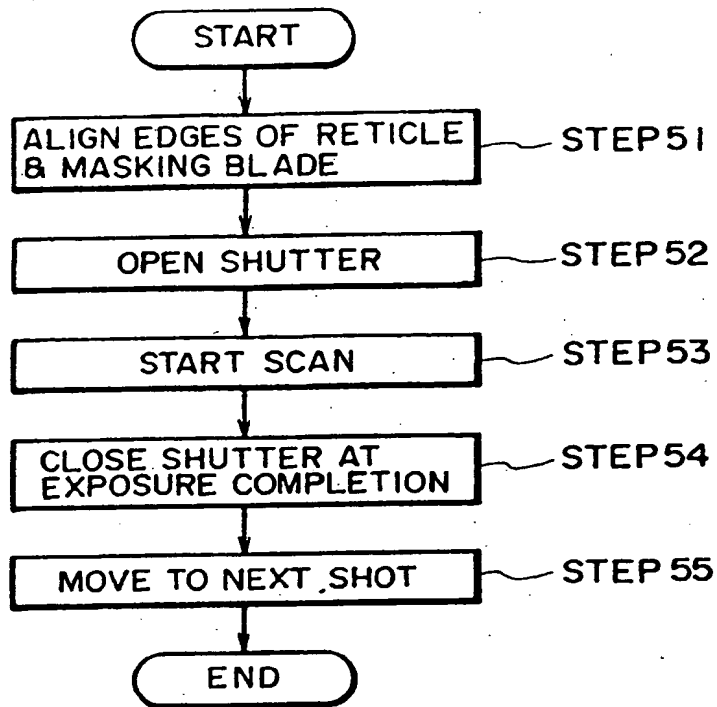


FIG. 5

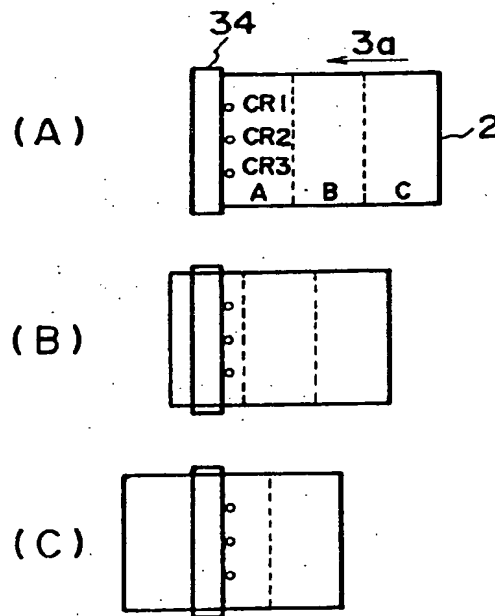


FIG. 6

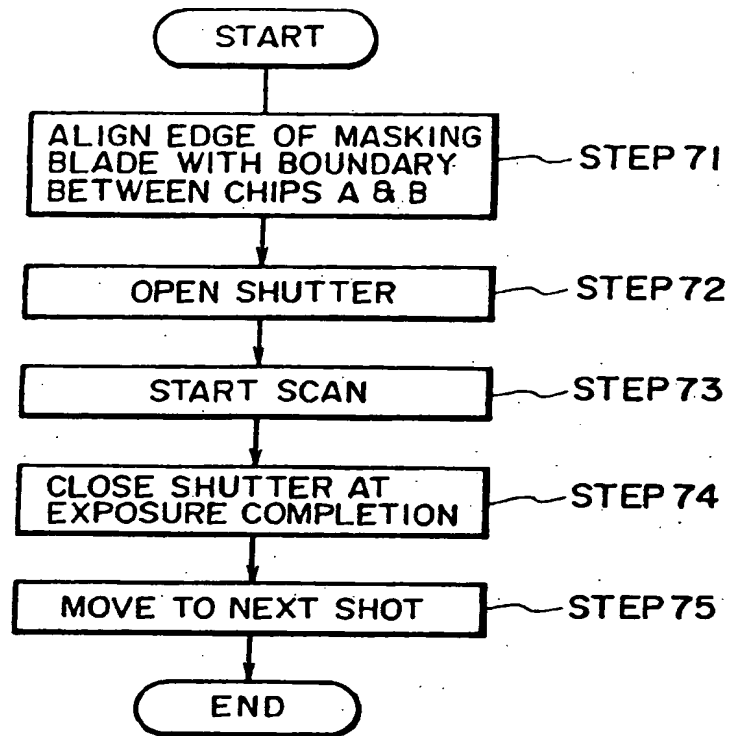


FIG. 7

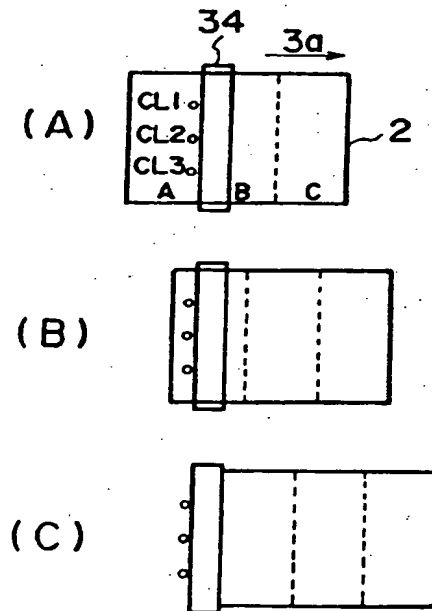


FIG. 8

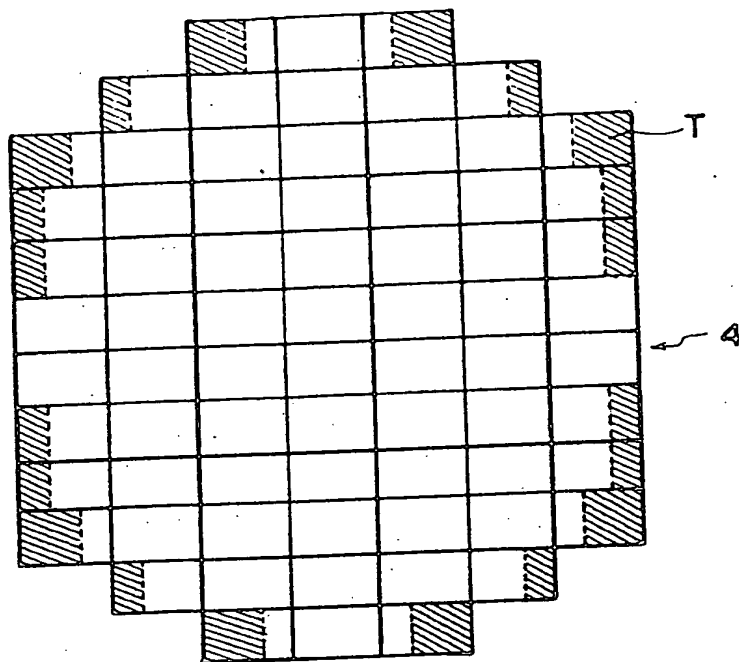


FIG. 9

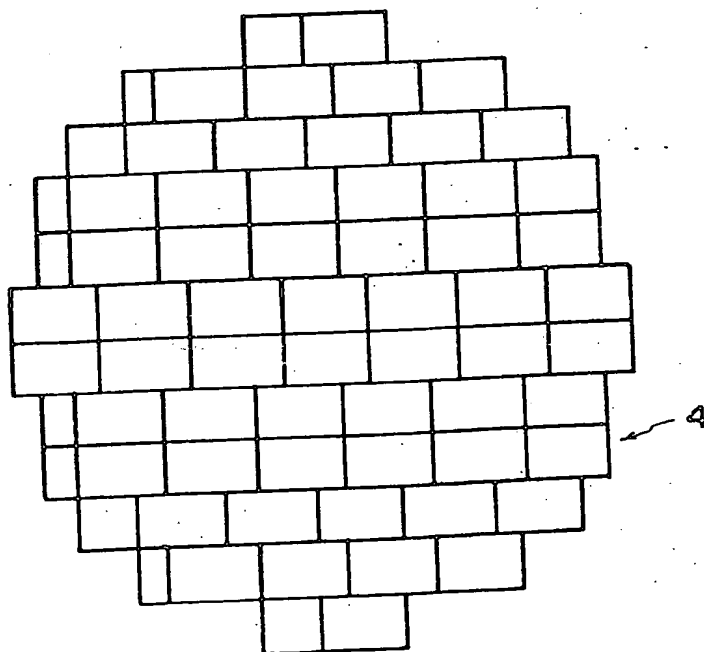


FIG. 10

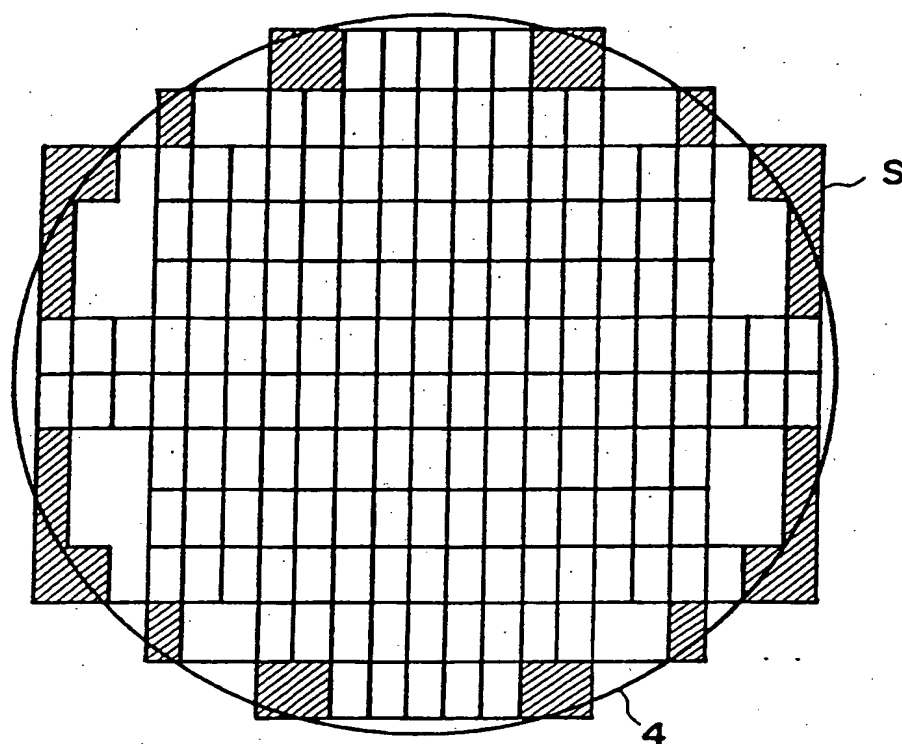


FIG. II



European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number  
EP 96 30 4965

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 633 506 (NIPPON KOGAKU KK) 11 January 1995 * page 2, line 1 - line 8 * * page 5, line 34 - line 43 * * page 11, line 48 - page 15, line 14 * * figures 1,10-15 *	1,3,4,6,8	G03F7/20
Y	---	2,5,7	
Y	EP-A-0 491 375 (TOKYO SHIBAURA ELECTRIC CO) 24 June 1992 * page 2 - page 5, line 2 * * figures *	2,5,7	
X	US-A-4 924 257 (JAIN KANTILAL) 8 May 1990 * column 1, line 1 - line 34 * * column 7, line 1 - column 8, line 11 * * figures 1,6-8 *	1,4,6,8	
A	US-A-4 530 587 (KOSUGI MASAO ET AL) 23 July 1985 * column 3, line 12 - column 4, line 20 * * figures 6-9 *	2,5,7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			G03F
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		23 October 1996	Heryet, C
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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